

CLAIMS

1. An integrated circuit structure comprising:

a body comprising a semiconductor substrate which has a top surface and a bottom surface, wherein one or more through holes pass through the substrate between the top and bottom surfaces, the body comprising one or more circuit elements formed in and/or over the top surface of the semiconductor substrate;

a conductor formed in each through hole and protruding from the bottom surface of the semiconductor substrate, the conductor in each through hole being coupled to one or more of the circuit elements;

a dielectric separating the conductor in each through hole from the semiconductor substrate, wherein at each through hole the dielectric forms a protrusion on the bottom of the body around the conductor;

wherein at each through hole the conductor protrudes from the dielectric on the bottom of the body, the conductor thus having a protruding outer surface not covered by the dielectric, wherein at least a portion of the protruding outer surface is either vertical or sloped outwards (laterally away from the through hole) when the surface is traced down.

2. The integrated circuit structure of Claim 1 wherein throughout each protrusion formed by the dielectric, the dielectric becomes gradually thinner around the adjacent conductor as the protrusion is traced down.

3. The integrated circuit structure of Claim 1 in combination with a first substrate, wherein the protruding outer surface of each conductor is attached to the first substrate with a bonding material to form a conductive bond between the conductor and the first substrate, wherein the bonding material reaches and at least partially covers said outer surface portion which is either vertical or sloped outwards.

4. The integrated circuit structure of Claim 3 in combination with the first substrate, wherein the bonding material comprises solder which bonds the conductor to the first substrate, wherein the solder reaches and at least partially covers said outer surface portion which is either vertical or sloped outwards.

5. The integrated circuit structure of Claim 3 in combination with the first substrate, wherein:

said portion of the protruding outer surface of the conductor is sloped outwards;
and

5 the bonding material fills the entire space between the integrated circuit structure and the first substrate.

6. The integrated circuit of Claim 1 wherein the conductor comprises a first conductive layer and a second conductive layer separating the first conductive layer from the dielectric;

10 wherein the second conductive layer is not present on the protruding outer surface.

7. The integrated circuit of Claim 6 wherein the first conductive layer is solder wettable, and the second conductive layer is not solder wettable.

8. An integrated circuit structure comprising:

15 a body comprising a semiconductor substrate which has a first surface and a second surface, wherein one or more through holes pass through the substrate between the first and second surfaces, the body comprising one or more circuit elements formed in and/or over the first surface of the semiconductor substrate;

20 a conductor formed in each through hole and protruding from the bottom surface of the semiconductor substrate, the conductor in each through hole being coupled to one or more of the circuit elements;

a dielectric separating the conductor in each through hole from the semiconductor substrate, wherein at each through hole the dielectric forms a protrusion on the bottom of the body around the conductor;

25 wherein throughout each protrusion formed by the dielectric, the dielectric becomes gradually thinner around the adjacent conductor as the protrusion is traced down.

9. The integrated circuit structure of Claim 8 wherein at each through hole the conductor protrudes from the dielectric on the bottom of the body.

10. The integrated circuit structure of Claim 8 in combination with a first substrate, wherein the protruding portion of each conductor is attached to the first
5 substrate.

11. An integrated circuit fabrication method comprising:

(a) forming one or more openings in a first generally horizontal surface of a semiconductor substrate;

(b) forming a first dielectric and a conductor in each of the one or more openings
10 with the conductor in each of the openings being separated from the substrate by the first dielectric;

(c) removing material from a second generally horizontal surface of the substrate to expose the first dielectric and turn the one or more openings into through holes, and removing the exposed first dielectric to expose the conductor at the second surface of the
15 substrate, such that the first dielectric forms a protrusion at each opening at the second surface, and the conductor protrudes from the first dielectric at each protrusion of the first dielectric;

wherein the protruding portion of each conductor has an outer surface not covered by the dielectric, and at least a portion of the outer surface is either vertical or is sloped
20 outwards (laterally away from the through hole in which the conductor is formed) when the surface is traced in a direction away from the substrate.

12. The method of Claim 11 wherein the removing operation (c) comprises a simultaneous etch of the substrate and the first dielectric, such that the first dielectric is etched both vertically and horizontally.

25 13. The method of Claim 11 further comprising attaching the protruding portion of each conductor to a first substrate with a bonding material to form a conductive bond between the conductor and the first substrate, wherein the bonding material reaches and at least partially covers said outer surface portion which is either vertical or sloped outwards.

14. The method of Claim 13 wherein the bonding material comprises solder which bonds the conductor to the first substrate, wherein the solder reaches and at least partially covers said outer surface portion which is either vertical or sloped outwards.

15. The method of Claim 13 wherein said portion of the protruding outer
5 surface of the conductor is sloped outwards.

16. The method of Claim 11 wherein:

forming the conductor comprises forming a first conductive layer and a second conductive layer separating the first conductive layer from the dielectric;

wherein the method further comprises removing the second conductive layer
10 during and/or after the operation (c) to expose the first conductive layer at the bottom of the substrate.

17. The method of Claim 16 wherein the first conductive layer is solder wettable, and the second conductive layer is not solder wettable.

18. An integrated circuit fabrication method comprising:

15 forming one or more openings in a top surface of a semiconductor substrate, wherein each opening has a sidewall, and at least a first portion of the sidewall is either vertical or sloped outwards relative to the opening when the sidewall is traced down;

forming a first dielectric and a conductor in each opening with the conductor in each opening being separated from the substrate by the first dielectric;

20 removing material from a bottom surface of the substrate to expose the first dielectric and turn the one or more openings into through holes, and removing the exposed first dielectric to expose the conductor at the bottom surface of the substrate, such that the first dielectric forms a protrusion at each opening at the bottom surface, and the conductor protrudes from the first dielectric at each protrusion of the first dielectric;

25 wherein the removing operation (c) removes the semiconductor material from said first portion of the sidewall of each opening, and removes the dielectric adjacent to the

first sidewall portion of the opening, to expose the conductor adjacent to the first sidewall portion of the opening.

19. The method of Claim 18 wherein the removing operation (c) comprises a simultaneous etch of the substrate and the first dielectric, such that the first dielectric is etched both vertically and horizontally.

20. The method of Claim 18 further comprising attaching the protruding portion of each contact to a first substrate with a bonding material which reaches and at least partially covers said exposed conductor which was adjacent to the first sidewall portion of each opening.

21. The method of Claim 20 wherein the bonding material comprises solder which bonds the conductor to the first substrate, wherein the solder reaches and at least partially covers said outer surface portion which is either vertical or sloped outwards.

22. The method of Claim 20 wherein said portion of the protruding outer surface of the conductor is sloped outwards; and
the bonding material is anisotropic adhesive.

23. The method of Claim 18 wherein:
forming the conductor comprises forming a first conductive layer and a barrier layer preventing intermixing between the first conductive layer and the dielectric;
wherein the method further comprises removing the barrier layer during and/or after the operation (c) to expose the first conductive layer at the bottom of the substrate.

24. The method of Claim 23 wherein the first conductive layer is solder wettable, and the second conductive layer is not solder wettable.

25. An integrated circuit fabrication method comprising:
forming one or more openings in a first surface of a semiconductor substrate;
forming a dielectric and a conductor in each of the one or more openings with the conductor in each of the openings being separated from the substrate by the dielectric;

removing material from a second surface of the substrate to expose the dielectric and turn the one or more openings into through holes, and removing the exposed dielectric to expose the conductor at the second surface of the substrate, such that at each through hole the dielectric forms a protrusion around the conductor at the second surface;

- 5 wherein the removing operation comprises a simultaneous etch of the substrate and the first dielectric, such that the first dielectric is etched both vertically and horizontally.

26. The method of Claim 25 wherein the conductor protrudes from the dielectric at each protrusion of the dielectric.

- 10 27. The method of Claim 26 further comprising soldering the protruding portion of each conductor to a first substrate.